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(71) **Applicant:** TELEFONAKTIEBOLAGET LM ERICSSON [SE/SE]; S-126 25 Stockholm (SE).

(72) **Inventor:** SAWYER, François; 1895 Mégantic, S.-Hubert, Quebec J3Y 7H7 (CA).

(74) **Agents:** LÖVGREN, Tage et al.; Telefonaktiebolaget LM Ericsson, S-126 25 Stockholm (SE).

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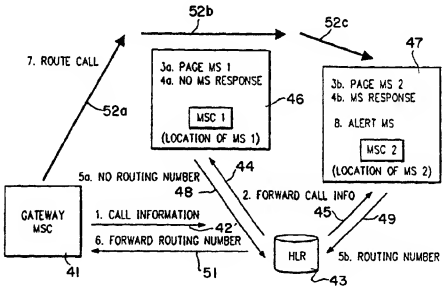

(57) **Abstract**

A method and system for implementing extension phone service within a mobile radio communication system. A plurality of mobile stations (M1-M10) are assigned to a single subscriber number and a record maintained as to the current location of each mobile station. In response to a call received for the subscriber number, each mobile station (M1-M10) is paged in the respective mobile switching center (MSC) in which it is currently located. The call is selectively routed to one of the mobile stations responding to the page request in accordance with preselected criteria (31) such as, the first mobile station to respond (32), the mobile station which is closest to the calling party (37), etc.

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SYSTEM FOR IMPLEMENTING EXTENSION PHONES WITHIN A CELLULAR RADIO TELECOMMUNICATIONS SYSTEM

BACKGROUND OF THE INVENTION

History of the Prior Art

Cellular radio communication service is defined and specified by a plurality of industry standards adopted by groups comprised of both manufacturers and operators of cellular systems. For example, the EIA/TIA requirements as set forth in Standard IS-41-B provide that a call within a cellular radio system is initially routed to a particular mobile switching center (MSC) in accordance with location data identifying the called mobile station (MS) which is stored in the home location register (HLR) of that particular subscriber. Thereafter, paging of the called mobile station takes place in the MSC to which the call is routed and, if the location data stored in the HLR is correct and the mobile station is currently in an active and powered on state, the MS responds to the page and the call will be completed.

Another recent EIA/TIA Standard, IS-53, contemplates that extension phones may be provided to mobile stations within the cellular system. In such an implementation, a single directory number within the system would be associated with two or more individual mobile stations, each of which would have a different mobile identification number (MIN) and a different electronic serial number (ESN). Thus, in order to provide extension phone service, the HLR must keep separate sets of location data for each of the two or more mobile units that have been assigned the same directory number. The idea behind cellular extension phone service specified by IS-53 is that the two or more extension phones would be paged simultaneously and the call would be completed to the first extension phone to respond. If the extension phones are located

within an area served by the same MSC, a call to a directory number associated with two or more extension phones could be completed by simultaneously paging each of those extension phones in that MSC and then completing the call to the first one that responds in accordance with IS-41-B. However, if one or more of the extension phones associated with the same directory number are located in different MSCs, such implementation of extension phone service is not possible. That is, a call cannot be routed to more than one MSC at the same time in current cellular networks.

The provision of extension phone service within a mobile radio communication system, such as a cellular system or a personal communication system (PCS), would be very useful in a number of different applications. For example, a cellular subscriber may want to have only a single directory number assigned to his/her service, but yet receive calls on a mobile station installed in a car when it is being used and on a transportable/portable instrument on other occasions. This would provide an optimum level of convenience for such a subscriber and simplify both the cost and service by only requiring a single directory number. In other applications of cellular extension phone service, a service provider such as a delivery service, or an emergency ambulance service, may desire to have only a single directory listing for calls for its service yet have such calls directed to and responded to by either the unit which was most readily available or the unit which was physically closest to the person requesting the service from the provider. Such an implementation would greatly enhance the efficiency of such service providers and enable, in the case of emergency service such as ambulance, fire, police,

etc., an efficient directing of service requests to those able to provide the most rapid response.

The system of the present invention enables the implementation of extension phone service within a mobile radio communication system, in a way which is highly efficient and effective.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides the assignment of a single directory number to two or more mobile stations each having different MINs. When a call is received by the HLR to which that directory number is assigned, a paging message is sent to each MSC within which each of the extension phone mobile stations is shown to be located within the records of the HLR. The mobile stations are paged in each MSC. The call is routed to the MSC within which the first mobile station to respond to the page is located and the call completed to that station whether or not it is the only station responding or the first of a plurality stations which may respond.

In another aspect, the system of the present invention pages each mobile station extension associated with the directory number being called simultaneously, but routes the call to the MSC of the mobile station which is geographically closest to the calling party.

In a still further aspect, the invention includes providing extension phone service within a mobile radio communication system by associating a plurality of mobile stations, each having a unique identification, with a single subscriber number. A call received at an exchange is directed to the subscriber number with which a plurality of mobile stations are associated. A list of parameters is maintained in a database which

identifies each mobile station associated with the subscriber number and the exchange within which each of the mobile stations is believed to be currently located. A routing request message is sent to the location within which each mobile station is specified in the database as currently being located. Each mobile station is paged in the exchange at which a routing request was received. An indication as to which ones of the mobile stations have responded to a page is received at the call receiving exchange and the call is selectively routed to one of the mobile stations as to which a page response was received.

In yet another aspect of the invention, calls are routed within a cellular radio system in which a single subscriber number may be associated with one or more mobile stations, each having a unique mobile identification number. A location request message is received from an interrogation exchange indicative of a call to a subscriber having a single subscriber number. Whether or not there is more than one mobile station associated with the single subscriber number for which the location request message was received is determined. The call is completed to the mobile station in response to a determination that there is only one mobile station associated with the single subscriber number. In response to a determination that there is more that one mobile station identification number associated with the single subscriber number, a routing request message for each of the associated mobile station identification numbers is sent to the current location at which the mobile station is believed to be located. Each mobile station identification number is paged at the location in response to the receipt of a routing request message. The receipt of page responses from each of the pages is

monitored for a preselected period of time and a recovery procedure is initiated in response to failure to receive any page responses during the preselected period of time. The call is completed to the mobile station from which a page response is received in response to the receipt of only one page response. A call routing decision is made in accordance with predefined criteria in response to the receipt of more than one page response from the paged mobile stations and the call is routed from the interrogation exchange to one of the plurality of mobile stations in accordance with the call routing decision.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a pictorial representation of a cellular radio communication system including a mobile switching center, a plurality of base stations, and a plurality of mobile stations;

FIG. 2 is a block diagram illustrating the routing of calls within a cellular radio telecommunications system in accordance with prior art routing standards;

FIG. 3 is a message exchange diagram illustrating the routing of a call within a cellular radio telecommunications system in accordance with prior art routing standards;

FIG. 4 is a flow chart illustrating cellular extension service provided in accordance with the present invention; and

FIG. 5 is an illustrative diagram setting forth one aspect of the implementation of extension phone

service in a cellular radio telecommunications system in accordance with the teachings of the present invention.

DETAILED DESCRIPTION

Referring first to FIG. 1, there is illustrated a conventional cellular radio communications system of the type to which the present invention generally pertains. In FIG. 1, an arbitrary geographic area may be divided into a plurality of continuous radio coverage areas, or cells C1-C10. While the system of FIG. 1 is illustratively shown to include only 10 cells and 1 MSC, it should be clearly understood that in practice, the number of MSCs and cells within each MSC will be much larger.

Associated with and located within each of the cells C1-C10 is a base station assigned as a corresponding one of a plurality of base stations B1-B10. Each of the base stations B1-B10 include a transmitter, a receiver, and a base station controller as are well known in the art. In FIG. 1, the base stations B1-B10 are illustratively located at the center of each of the cells C1-C10, respectively, and are equipped with omni-directional antennas. However, in other configurations of a cellular radio system, the base stations B1-B10 may be located near the periphery, or otherwise away from the centers of the cells C1-C10 and may illuminate the cells C1-C10 with radio signals either omni-directionally or directionally. Therefore, the representation of the cellular radio system of FIG. 1 is for purposes of illustration only and is not intended as a limitation on the possible implementations of the cellular radio system within which the system of the present invention is implemented.

With continuing reference to FIG. 1, a plurality of mobile stations M1-M10 may be found within the cells C1-C10. Again, only 10 mobile stations are shown in FIG. 1 but it should be understood that the actual number of mobile stations will be much larger in practice and will invariably greatly exceed the number of base stations. Moreover, while none of the mobile stations M1-M10 may be found in some of the cells C1-C10, the presence or absence of the mobile stations M1-M10 in any particular one of the cells C1-C10 should be understood to depend, in practice on the individual desires of the mobile stations M1-M10 who may roam from one location in the cell to another or from one cell to an adjacent cell or neighboring cell, and, in addition, from one cellular radio system served by a particular MSC to another such system served by a different MSC.

Each of the mobile stations M1-M10 is capable of initiating or receiving a telephone call through one or more of the base stations B1-B10 and a mobile switching center MSC. A mobile switching center MSC is connected by communication links, e.g., cables, to each of the illustrative base stations B1-B10 and to the fixed public switched telephone network PSTN, not shown, or a similar fixed network which may include an integrated services digital network (ISDN) facility. The MSC shown is also connected to other MSCs making up the cellular radio system network. The relevant connections between the mobile switching center MSC and the base stations B1-B10, or between the mobile switching center MSC and the PSTN or ISDN and other MSCs, are not completely shown in FIG. 1 but are well known to those of ordinary skill in the art. Similarly, it is also known to include more than one mobile switching center in a cellular radio system and to connect each additional mobile switching center to

a different group of base stations and to other mobile switching centers via cable or radio links.

Each of the cells C1-C10 is allocated a plurality of voice or speech channels and at least one access or control channel, such as a forward control channel (FOCC). The control channel is used to control or supervise the operation of mobile stations by means of information transmitted to and received from those units. Such information may include incoming call signals, outgoing call signals, page signals, page response signals, location registration signals, voice channel assignments and maintenance instructions. The control or voice channels may operate either in an analog or digital mode or a combination thereof.

Referring next to FIG. 2, there is shown a block diagram of a portion of a cellular radio system illustrating the routing of incoming calls within that system in accordance with EIA/TIA IS-41. In such call completion procedures, a call received for a directory number assigned to a mobile station is received at an interrogation exchange 11 which sends a location request signal 12 to the home exchange or home location register (HLR) associated with the mobile station to which the call is directed 13. The home exchange or HLR consults its database to determine the current physical location of the mobile station assigned to the directory number being called and identifies a particular visited exchange or visited location register within the system as the current location of the called mobile station. A routing request 14 is sent to the visited location register or visited exchange 15. Referring in more detail to the message exchange diagram shown in FIG. 3, the visited location register or visited exchange 15 sends a routing request return result 16 to the HLR 13, such message including

a temporary routing number. The HLR 13 forwards the temporary routing number in a location request return result message 17 to the interrogation exchange 11. The call is then routed to the current location of the mobile 18 where it is paged 19 and the call completed to the mobile if it responds to the page.

As illustrated in FIGS. 2 and 3, paging of a mobile station in accordance with IS-41 does not occur until after the call has been routed to the visited exchange. Thus, in the attempted implementation of extension phone service within a cellular radio system as functionally defined by IS-53, two different mobile stations assigned the same directory number cannot be paged simultaneously unless both stations are located in the same exchange. Of course, one could first route the call to an exchange where a first mobile station assigned to the directory number was believed to be located, page that mobile in that exchange and wait for it to respond and then, only after failure to receive a page response, advise the interrogation exchange to reroute the call to a second exchange where another mobile station extension assigned to that directory number was believed to be located. Such a process would be highly cumbersome, slow, and inadequate to supply the needs of the cellular radio industry.

A technique used in the system of the present invention is that of paging to locate a mobile station within a visited exchange prior to the routing of the call to that exchange. Thus, if the mobile station fails to answer the page, the call is never routed to the visited exchange saving substantial cost and time. Such techniques are described in co-pending U.S. patent application serial no. 07/756,487, filed September 25, 1991, entitled "Apparatus and Method of Directing Calls to Mobile Telephone Subscribers", in the name of John

Hayes, et al. and U.S. patent application serial no. 07/516,122, filed April 27, 1990, entitled "Multi-Exchange Paging System for Locating a Mobile Telephone in a Wide Area Telephone Network", in the name of Nancy Buhl, et al., both of which are assigned to the assignee of the present invention and incorporated by reference herein.

In the present system, when a call directed to a mobile subscriber is received at an interrogation exchange, the HLR of that subscriber is consulted to obtain information identifying the MSC serving its present location. That MSC is then requested to page the mobile station and then respond to the HLR with an indication as to whether or not the mobile station was found. If the mobile station has responded to the page, the call is then routed to that MSC for completion of the call to the mobile station. This concept of paging a mobile station prior to routing the call was introduced primarily to overcome the uncertainties in the location data stored in the HLR for a cellular subscriber and minimize needless routing of calls to improper locations and the attendant circuit time associated therewith. The paging prior to routing concept is expanded in the system of the present invention to provide efficient implementation of extension phone service within a cellular radio telephone system.

In the present system, a home location register maintains location data independently for each mobile station within a group of mobile stations assigned to the same directory number. Upon the receipt of a call to be terminated to that directory number, the interrogation exchange requests the MSCs identified in the HLR location data corresponding to the believed current location of each mobile station to page each

mobile station in accordance with its MIN/ESN. All of the MSCs then page the relevant mobile stations in a quasi-simultaneous fashion regardless to their proximity to or separation from one another. Since each mobile unit being paged is identified by a separate MIN/ESN, all of the mobile units associated with the directory number may be located in the same MSC and paged there simultaneously. Similarly, all mobile units may be located in different MSCs and each paged separately in its respective MSC. All paging requests from the interrogation exchange to the MSCs are treated independently from one another since each MS is identified by a specific MIN/ESN combination, or otherwise, by specific data used on the air interface of the system.

After the page requests are executed, each MSC in which an MS was paged reports to the interrogation exchange as to whether or not a page response has been received from the paged mobile station. The interrogation exchange then routes the call to one of the MSCs which has received a page response from the paged mobile station. Different techniques can be used to select which mobile station extension phone the call is to be routed to in the event more than one mobile station answered the page from its associated MSC. Several different criteria can be used by the HLR to make the selection. For example, the interrogation exchange may select to route the call toward the MSC which first sends it a positive acknowledgement indicating that the paged mobile station has answered the page and/or been placed on a voice channel in that MSC. In addition, each mobile station in a group of mobile stations assigned as extension phones to the same directory number may have preassigned priorities and the HLR may treat multiple responses in accordance

with these assigned priorities. The assigned priorities may be permanently fixed as to the respective extension phones or they may be subject to change within the database in accordance with a preselected priority modification algorithm. Further, the interrogation MSC may analyze the location of the calling party by using the MSC identity of the originating MSC and the location where the page response was received using the MSC-ID of the MSC having obtained the page responses. These data may be used in order to route the call toward the responding mobile station that is closest to the caller. This would be a particularly useful call routing scheme in the case of emergency services such as the use of extension phones in ambulances, police cars, etc.

Referring next to the flow chart shown in FIG. 4, there is illustrated a procedure by which extension phones within a cellular radio system may be implemented in accordance with the teachings of the present invention. In FIG. 4, the system receives at 21 a location request message regarding a call to a subscriber with a given subscriber number. At 22, the system determines whether or not more than one mobile identification number (MIN) exists for the subscriber number to which the call is directed. If not, the system moves to 23 at which the call is delivered to the mobile station corresponding to the MIN assigned to the subscriber number to which the call is directed and in accordance with the procedure specified in EIA/TIA IS-41, for example. If, however, at 22, it is determined that more than one mobile station identified by more than one MIN has been assigned to the subscriber directory number to which the call was directed, the system moves to 24 and the HLR of the directory number sends a routing request message for

each MIN to the VLR or visited MSC identified in the HLR database as being the current location of each of the mobile stations corresponding to each MIN assigned to that subscriber number. At 25, each mobile station corresponding to each MIN is then paged at the relevant VLR/MSC for each of the routing messages received by it from the interrogation exchange sending the multiple messages. At 26, the HLR monitors the responses received from the routing requests sent out to the several VLR/MSCs for a selected period of time.

If, at 26, the HLR receives no signals in response to the routing request messages it sent to each MSC identified as the current location of a mobile station corresponding to each MIN, then the system moves to 27 and initiates recovery procedures for no page response such as, for example, call transfer to another number or a no response signal to the calling party. Thereafter, the routing ends at 28. If, at 26, only one response was received by the HLR, indicating that only one of the paged MSs responded by sending a page response signal to its paging MSC, then the system moves to 29 and the call is delivered to the extension phone of the mobile station identified by the MIN responding to the page at the MSC where it is currently located.

If, at 26, the HLR receives two or more messages indicating the receipt of page responses from the paged MSs, the system moves to 31 at which routing decisions based upon predefined criteria are evaluated for this particular subscriber number. For example, the system might move to 32 at which the call would be routed toward the MSC associated with the mobile station having the MIN which first responded to a page after the routing requests were sent from the HLR. In such a case, the system would then deliver the call to the

extension phone of the mobile station having the MIN first responding to the page at 33 and then end at 28. Alternatively, the system could move from the routing decision at 31 to a criterion beginning at 34 in which the call was to be routed in accordance with certain priorities assigned to the various MINs associated with the various plurality of extension phone mobile stations assigned to the subscriber number. At 35, the responses are arranged in priority order after they have been received from the MSCs at which page responses were received for each MIN. Finally, at 36, the call is delivered to the extension phone corresponding to the MIN with the highest priority responding to the page and then the routine ends at 28.

By way of further alternative, the routing decision contained within the criteria at 31 may include movement to 37 at which the call is to be routed toward the mobile station located closest to the calling subscriber. In this case, the system then moves to 38 at which it calculates the distances between the interrogation exchange and the VLR/MSC at which page responses were received from the mobile extension phones having MINs as to which a page response was received. This can be implemented by means of a lookup table or a predefined algorithm driven by the location of the interrogating exchange and the location of the various MSCs. Finally, the call is delivered to the extension phone which is closest to the calling subscriber. The latter technique of call routing may be particularly applicable in the case of emergency services such as police, fire, ambulance, etc.

Referring next to FIG. 5, there is shown a block diagram/flow diagram, in which a sequence of steps are illustrated in the implementation of extension phone

service within a cellular radio system in accordance with the teachings of the present invention. As shown in FIG. 4, a call is received at an interrogation exchange or gateway MSC 41 for a particular directory number to which a plurality of extension phones, each having different identification criteria such as different MINs, ESNs, etc., are assigned. Next, information related to the call is sent at 42 to the HLR 43 corresponding to the directory number for which the call is intended. Assuming there are two extension phone mobile stations, MS1 and MS2, identified within the HLR as being associated with the directory number for which the call is intended, the HLR then forwards the call information at 44 and 45 to MSC1 46 and MSC2 47 identified, respectively, in the database of the HLR as being the current location of MS1 and MS2, respectively. Next, MSC1 pages MS1 within its location and MSC2 pages MS2 in its location. As illustrated, no page response is received from MS1 at MSC1, but a page response is received from MS2 at MSC2. Thus, a no routing message 48 is sent from MSC1 to HLR 43 while a routing number message 49 is sent from MSC2 to the HLR 43. The routing number is forwarded in a message 51 from the HLR 43 to the gateway MSC 41 and, thereafter, the incoming call to the gateway MSC 41 is routed at 52a-c to MSC2 47 for completion of the call to MS2.

Thus, it can be seen from the above description that extension phone service within a cellular radio system may be enabled in a logical and orderly manner in accordance with the teaching of the present invention. The present invention provides optimized cellular radio extension phone service in a manner which can be flexibly configured in accordance with the particular needs of the cellular radio subscriber requesting such service.

For instance, the invention described herein could be applied with the same method and principles to other types of mobile radio communication such as those proposed for Personal Communications Services (PCS). PCS may provide call delivery in a manner similar to that of cellular radio systems but employ other air interface techniques not currently considered "cellular", such as CT2, CT2+, CT3, DECT and others. The present system for implementing extension phone service could be implemented within such PCS systems. In another example, the method and principles of the present invention described herein could use an implementation whereby, upon detection of a call to a single directory number, the HLR consults another database called a Service Control Point (SCP) to obtain the list of MINs attached to the directory number along with the criteria for selection of a page response, priority for each MIN, geographical data and any other related information. The SCP can be co-located with an HLR or can be a distinct node within the cellular network.

It is believed that the operation and construction of the present invention will be apparent from the foregoing description. While the method and apparatus shown and described has been characterized as is being preferred, obvious changes and modifications may be made therein without departing from the spirit and scope of the invention as defined in the following claims.

WHAT IS CLAIMED IS:

1. A method for providing extension phone service within a mobile radio communication system, comprising:

associating a plurality of mobile stations, each having a unique identification, with a single subscriber number;

receiving a call directed to said subscriber number to which a plurality of mobile stations are associated;

maintaining in a database a list of parameters identifying each mobile station associated with said subscriber number and the exchange within which each of said mobile stations is believed to be currently located;

sending a routing request message to the location within which each mobile station is specified in the database as currently being located;

paging each mobile station in the exchange at which a routing request was received;

receiving an indication as to which ones of said mobile stations have responded to a page; and

selectively routing the call to one of the mobile stations as to which a page response was received.

2. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said page response indication receiving step comprises:

starting a timer for measuring a preselected time period after sending said routing request messages;

initiating recovery procedure in response to the failure to receive a page response indication within said preselected time period.

3. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said selective routing step comprises:

routing the call to only one of a plurality of mobile stations from which page responses were received, said one being selected in accordance with a set of preselected criteria.

4. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said selective routing step comprises:

storing in a database a priority indication with respect to each of said mobile stations associated with said single subscriber number;

consulting said database in response to the receipt of a paging response indication with respect to more than one of said mobile stations; and

routing the call to the mobile station having the highest priority among those from which a page response was received.

5. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said selective routing step comprises:

selectively routing the call to the first one of the mobile stations from which a page response was received.

6. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said selective routing step comprises:

storing in a database a table of geographic relationships between exchanges from which calls for mobile subscriber numbers may be received and exchanges within which mobile stations associated with those numbers may be located;

consulting said table in response to the receipt of a paging response indication with respect to more than one of said mobile stations; and

routing the call to the mobile station from which a page response was received which is geographically closest to the exchange from which the call for said subscriber number was received.

7. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1, wherein said selective routing step comprises:

storing an algorithm for calculating the geographic relationships between exchanges from which calls for mobile subscriber numbers may be received and exchanges within which mobile stations associated with those numbers may be located;

calculating with said algorithm, in response to the receipt of a paging response indication with respect to more than one of said mobile stations, the respective distances between the exchange from which the call for said subscriber number was received and the plurality of exchanges from which a page response was received; and

routing the call to the mobile station from which a page response was received which is geographically closest to the exchange from which the call for said subscriber number was received.

8. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1 in which said database is maintained within a home location register associated with said subscriber number.

9. A method for providing extension phone service within a mobile radio communication system as set forth in claim 1 in which said routing request message is sent to a visited location register identified in said database.

10. A method for providing extension phone service within a mobile radio communication system as set forth in any of claims 1-9 in which said system is a cellular radio system and in which the location at which a call is received and from which said call is routed is an interrogation exchange.

11. A system for providing extension phone service within a mobile radio communication system, comprising:

means for associating a plurality of mobile stations, each having a unique identification, with a single subscriber number;

means for receiving a call directed to the subscriber number to which a plurality of mobile stations are associated;

means for maintaining in a database a list of parameters identifying each mobile station associated with said subscriber number and the exchange within which each of said mobile stations is currently believed to be located;

means for sending a routing request message to the location within which each mobile station is specified in the database as currently being located;

means for paging each mobile station in the location at which a routing request was received;

means for receiving an indication as to which ones of said mobile stations have responded to a page; and

means for selectively routing the call to one of the mobile stations as to which a page response was received.

12. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said page response indication receiving means comprises:

means for starting a timer for measuring a preselected time period after sending said routing request messages;

means for initiating recovery procedure in response to the failure to receive a page response indication within said preselected time period.

13. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said selective routing means comprises:

means for routing the call to only one of a plurality of mobile stations from which page responses were received, said one being selected in accordance with a set of preselected criteria.

14. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said selective routing means comprises:

means for storing in a database a priority indication with respect to each of said mobile stations associated with said single subscriber number;

means for consulting said database in response to the receipt of a paging response indication with respect to more than one of said mobile stations; and

means for routing the call to the mobile station having the highest priority among those from which a page response was received.

15. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said selective routing means comprises:

means for selectively routing the call to the first one of the mobile stations from which a page response was received.

16. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said selective routing means comprises:

means for storing in a database a table of geographic relationships between exchanges from which calls for mobile subscriber numbers may be received and exchanges within which mobile stations associated with those numbers may be located;

means for consulting said table in response to the receipt of a paging response indication with respect to more than one of said mobile stations; and

means for routing the call to the mobile station from which a page response was received which is geographically closest to the exchange from which the call for said subscriber number was received.

17. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11, wherein said selective routing means comprises:

means for storing an algorithm for calculating the geographic relationships between exchanges from which calls for mobile subscriber

numbers may be received and exchanges within which mobile stations associated with those numbers may be located;

means for calculating with said algorithm, in response to the receipt of a paging response indication with respect to more than one of said mobile stations, the respective distances between the exchange from which the call for said subscriber number was received and the plurality of exchanges from which a page response was received; and

means for routing the call to the mobile station from which a page response was received which is geographically closest to the exchange from which the call for said subscriber number was received.

18. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11 in which said database is maintained within a home location register associated with said subscriber number.

19. A system for providing extension phone service within a mobile radio communication system as set forth in claim 11 in which said routing request message is sent to a visited location register identified in said database.

20. A system for providing extension phone service within a mobile radio communication system as set forth in any of claims 11-19 in which said system is a cellular radio system and in which the location at which a call is received and from which said call is routed is an interrogation exchange.

21. A method for routing calls within a mobile radio communication system in which a single subscriber number may be associated with one or more mobile stations, each having a unique mobile identification number, said method comprising:

receiving at a location a location request message from an exchange indicative of a call to a subscriber having a single subscriber number;

determining whether or not there is more than one mobile station associated with said single subscriber number for which said location message was received;

completing said call to the mobile station in response to a determination that there is only one mobile station associated with said single subscriber number;

sending, in response to a determination that there is more that one mobile station identification number associated with said single subscriber number, a routing request message for each of said associated

mobile station identification numbers to the current location at which said mobile station is believed to be located;

paging each mobile station identification number at said location in response to the receipt of a routing request message;

monitoring for a preselected period of time the receipt of page responses from each of said pages;

initiating a recovery procedure in response to failure to receive any page responses during said preselected period of time;

completing the call to the mobile station from which a page response is received in response to the receipt of only one page response;

making a call routing decision in response to the receipt of more than one page response from said paged mobile stations in accordance with predefined criteria; and

routing said call from said exchange to one of said plurality of mobile stations in accordance with said call routing decision.

22. A method for routing calls within a mobile radio communication system in which a single subscriber number may be associated with one or more mobile stations, each having a unique mobile identification

number, as set forth in claim 21 in which said step of making said call routing decision includes:

assigning priorities to each of said mobile stations associated with said single subscriber number; and

routing said call to the mobile station having the highest priority from which a page response was received.

23. A method for routing calls within a mobile radio communication system in which a single subscriber number may be associated with one or more mobile stations, each having a unique mobile identification number, as set forth in claim 21 in which said step of making said call routing decision includes:

determining which one of said mobile stations from which a page response was received is closer to the calling party from which said call was received for said subscriber number; and

routing said call to said mobile station.

24. A method for routing calls within a mobile radio communication system as set forth in any of claims 21-23 in which said system is a cellular radio system and in which the location at which a call is received and from which said call is routed is an interrogation exchange.

FIG.1

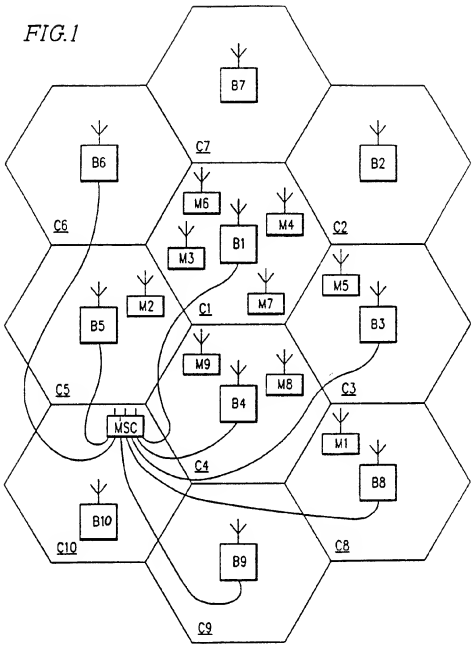

FIG. 2

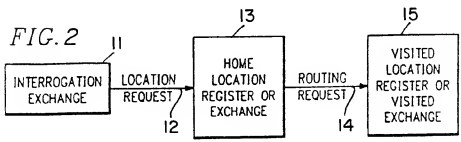

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FIG.5

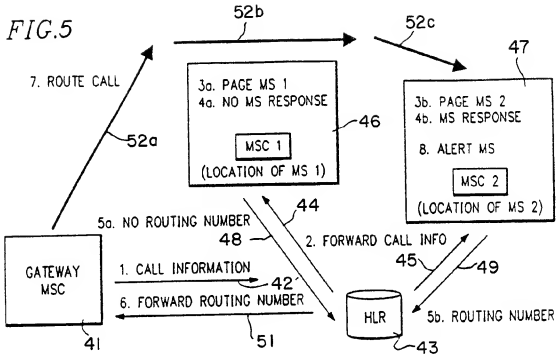

FIG.3

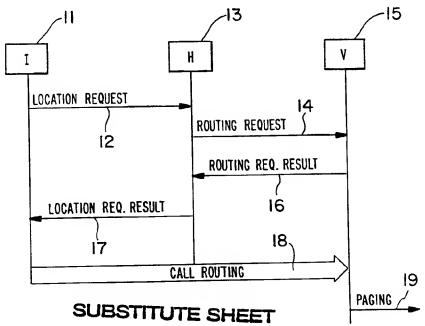

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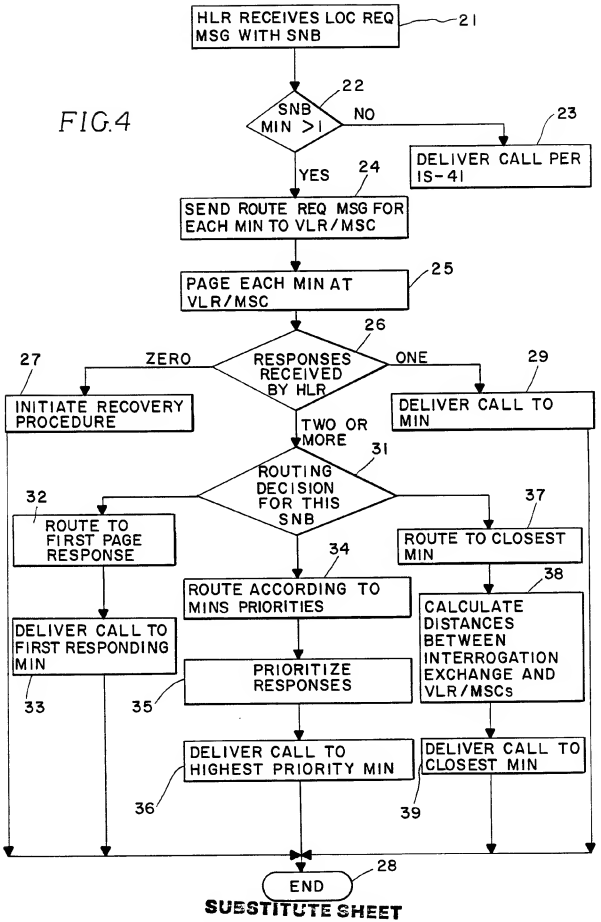
FIG.4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00035

A. CLASSIFICATION OF SUBJECT MATTER

IPC : H04Q 7/04, H04M 3/42, H04B 7/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC : H04B, H04M, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, INSPEC, CLAIMS, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	US, A, 5206901 (JOHN B. HARLOW ET AL), 27 April 1993 (27.04.93), column 2, line 9 - column 3, line 17; column 3, line 32 - column 6, line 24	1,4,5,11,14, 15,21
A	EP, A2, 0431453 (LICENTIA PATENT-VERWALTUNGS-GMBH), 12 June 1991 (12.06.91), see the whole document	1,11
P,A	EP, A2, 0526764 (POSTI-JA TELELAITOS), 10 February 1993 (10.02.93), see the whole document	1,11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 May 1994	09 -05- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bo Gustavsson Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT
Information on patent family members

16/04/94

International application No.
PCT/SE 94/00035

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5206901	27/04/93	CA-A- 2078598 EP-A- 0549126	24/06/93 30/06/93
EP-A2- 0431453	12/06/91	DE-A- 3939903	06/06/91
EP-A2- 0526764	10/02/93	NONE	

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